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Advanced Patient Monitoring System with Diseases Prediction System using Machine Learning

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ABSTRACT

IoT and machine learning (ML) are becoming increasingly efficient in the medical and telemedicine areas all around the world. This article describes a system that employs latest technology to give a more accurate method of forecasting disease. This technology uses sensors to collect data from the body of the patient. The obtained sensor information is collected with NodeMcU before being transferred to the Cloud Platform "ThinkSpeak" through an ESP8266 Wi-Fi module. ThinkSpeak is a cloud server that provides real-time data streams in the cloud. For the best results, data currently saved in the cloud is evaluated by one of the machine learning algorithms, the KNN algorithm. Based on the findings of the analysis and compared with the data sets, the disease is predicted and a prescription for the relevant disease is issued.

Keywords: *IOT, Machine learning, KNN Algorithm, Patient's body parameters, Sensors.*

1. Introduction

Telemedicine is one of the most promising areas in which the Internet-of -Things has proven to be cost-effective and productive in healthcare applications, particularly in the field of patient monitoring. In the field of cardiology, telemedicine combined with sensors can be used to a greater extent. This project covers the experience, the technique employed, and the various design considerations that must be taken in order for telemedicine to be effective in patient-monitoring systems. The method uses Internet of Things (IoT) technology for uploading to Webserver and telecommunication technologies for providing medical information and services. The sensors are used to capture biological parameters and are linked to mobile phones, allowing various patients to access data in concurrently. The discipline of biomedicine is no longer isolated in today's world of automation. Engineering and technology have shown to be important in the realm of biomedical research. It not only made doctors more efficient, but it also helped them improve the entire medicine process. In a number of healthcare situations, machine learning (ML) is already aiding. In health maintenance, machine learning aids in the analysis of numerous data parameters, the recommendation of findings, and the generation of appropriate reports.

The IoT describes the network of physical component "things" clubbed with sensors, soft-ware, and various technologies to communicate with other devices and share data through internet. These devices range from ordinary household objects to sophisticated industrial tools. All of these gadgets are capable of communicating with one another and taking critical steps that could save someone's life. An IoT healthcare device would collect data and transfer it to the cloud, where doctors could act on it.

Machine learning is a branch of artificial intelligence that is defined as a machine's ability to mimic intelligent human behavior. Artificial intelligence systems are utilized to complete complex jobs in a similar manner to how humans solve problems. Machine learning approaches in healthcare use the enormous quantity of health information offered by the IoT to enhance health chances. These methods have both intriguing uses and considerable limitations. In multispecialty hospitals with a large number of wards and a large number of patients in each ward, doctors are unable to monitor the patient at all times. For this, the doctor creates time slots, and each

ward is visited after a certain amount of time has passed. However, patients may experience issues in the intervals between these time frames. This causes patient inconvenience, and hospital management may feel helpless in the face of the problem.

2. Related Work

It is observed that, although there are numerous patient monitoring systems on the market, only a few of them integrate active network technology with a mobile interface for alerting as part of a case study on various patient monitoring systems. As per the study IFTTT is used to analyze sensor readings in a Google sheet, which is then converted into a csv file that looks like data. Decision Tree Algorithm and Random Backwoods Classifier Algorithm are two Machine Learning Algorithms that are used. SVM (Support vector machine) has a better accuracy rate when it comes to detecting heart disease. Need High speed internet for all the time for the update of health state and cost is high [1]. The system is developed in the next section utilizing a GUI-based application. This application was created with the help of a java application and a python website. These values are sent to the cloud server through GSM. On the websites, the most current values are presented. The device is larger in size and cannot taken everywhere by the patients if high weight [2].

After a specific period of time, all sensors Real-time data is automatically captured and cloud based updated, and if any unwanted sensor readings are identified, a recommended doctor from anywhere in the world is intimated through mobile SMS and GSM network. Previous data is replaced with current data, resulting in an incorrect analysis for the patient's health and an incorrect diagnosis by the doctor [3].

It should be noted that this assessment does not include accelerometer activity tracking for purposes such as activity identification, gait research, or rehabilitation. Many sensors come at a considerable cost, and they can only be used in hospitals, not for daily patient monitoring [4].

When it comes to showing sensor data, the smart application is contagious. To assess user data and anticipate CVDs in the smart application, deep or machine learning techniques were applied [5].

It does not give how the patients' health condition can be notified; it only predicts the health condition. It uses only ECG with the help of this parameter complete analysis of the patient cannot be predicted [6]. It does not give notification to the caretakers of the patient. It just monitored the health of the patients. The complete analysis of the patients can't be predicted [7].

PMS is a system that monitors health indicators continually and warns service providers when ambulatory difficulties arise using a palm-top-like device. It works in the same way as a point-to-point system [8-11]. Keeping one such system for each patient in a hospital with numerous patients becomes more expensive [12-15]. The suggested system has the ability to assess a range of physical characteristics in various patients, but it also uses the internet to transmit the status of those patients to authorities. The study focuses on the software components of creating a system that can access a database with a variety of patient health characteristics.

3. Necessity

Current hospital patient monitoring systems allow for continuous vital sign monitoring, but they need the sensors to be attached to nearby, bedside monitors or PCs, thereby limiting the patient to his hospital bed. A paramedical

assistant must continue to monitor and maintain these systems even after they have been attached to a specific patient. You can collect all of the patient's critical information by manually keeping track of all of the patient's records. Adopting such a system is prone to error, and if a human error occurs, it could result in catastrophe.

4. Problem Statement

Health condition monitoring in the home can provide significant physiological data. This monitoring is beneficial for elderly and chronically un-well individuals who do not want to stay in the hospital for an extended period of time. Current hospital patient-monitoring systems allow for continuous vital sign monitoring, but they need the sensors to be attached to nearby, bedside monitors or PCs, thereby limiting the patient to his hospital bed. A paramedical assistant must continue to monitor and maintain these systems even after they have been attached to a specific patient. By manually keeping track of all of the patient's records, you may collect all of the patient's vital information. Adopting such a system is prone to error and could result in tragedy if a human error occurs.

Wireless sensors capture and send signals of relevance, and a CPU is designed to automatically receive and interpret sensor data. Relevant sensors are selected based on what you want to detect and create algorithms to implement your detection. An approach to a remote health monitoring system was devised using a single parameter monitoring system, it brings healthcare to the patient's home from a regular health care facility.

The device was designed to collect data on heart-beat detection, height and weight, temperature, and a few other factors. The data collected by the Single-Parameter tracking devices then was availed for distant identification. During the design process, the following aspects of potential medical applications were considered:

(a) The integration of a created device with current medical procedures and technology.

(b) Extended-term, legitimate efficient patient monitoring, compact, wearable sensors, and long battery life.

(c) Assistance to the senior and chronically-ill. The gadget should be simple to operate, with only a few buttons.

(d) At the very least, a first-aid prescription should be provided.

5. Proposed Work

Patients who are unable to get to the hospital must now travel for a period of time. However, the health of certain elderly people might change from time to time. So, we're attempting to address this problem with our concept, in which a person's health will be monitored on a daily basis by a wear-able gadget. All of the data, including heartbeat, pressure, and temperature, is transferred to the cloud, where machine learning is applied to the data. In the event of an emergency, an auto prescription will be sent to the patient via the application. Machine learning's primary function is to classify whether hardware sensor data is normal or not. It is done by using the KNN algorithm. The KNN (K-Nearest Neighbor) categorization technique generally applicable in various domains due to its simplicity. The KNN technique classification effectiveness is significantly reduced when the sample size is large and the number of feature characteristics is large. This research introduces and compares an improved KNN method to the traditional KNN method. The classification is done in the standard KNN classifier's query instance neighborhood, with weights assigned to each class. To ensure that the imposed weight does not have an unfavorable influence on outliers, the approach takes into account the class distribution surrounding the query

instance. The medical features in the data set are matched with real hardware data using machine learning, which results in an accurate status that lowers time complexity and perhaps saves many lives.

5.1. Advantage of proposed work

The system's key benefit is its security, as well as it is capable to communicate sensor data and execute machine learning over the internet. Doctors can connect to the database server to compare a patient's present condition to his or her medical history. The patient's sensor data is continually monitored by the machine learning process. It allows multivendor off-the-shelf hard-ware devices to plug and play, avoiding proprietary standards.

6. Block Diagram

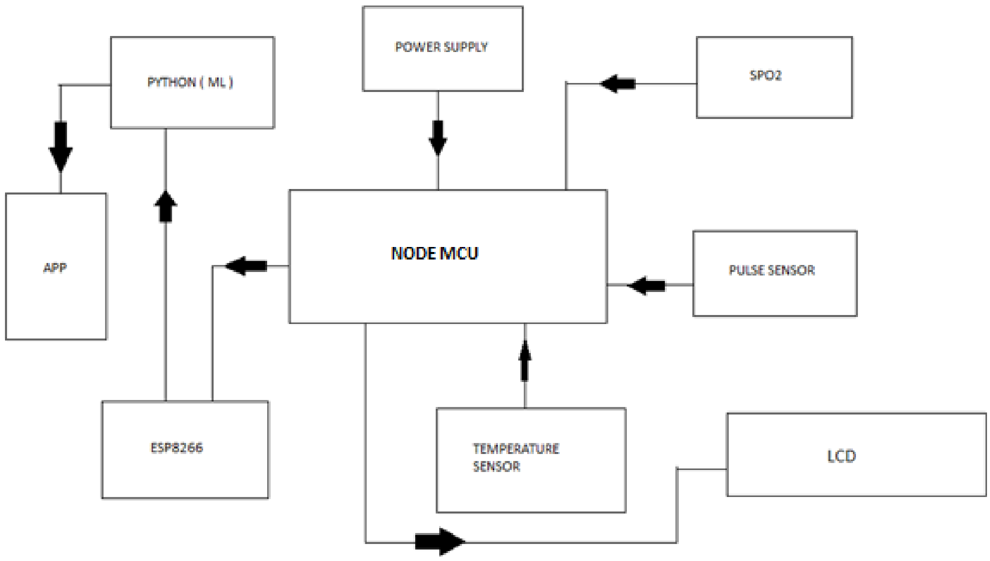

Fig.1. Block diagram of the proposed system

7. HARDWARE DESCRIPTION

7.1. NODEMCU

NodeMCU can connect objects and let data transfer using the Wi-Fi protocol. It is easy to use because it has a inbuilt Wi-Fi module facility.it consumes low energy and power. It is also small in size, so the size of the project is getting reduced.it is even low in cost when compared to other Microcontrollers.

NodeMCU may be powered via a Micro USB and a VIN pin (External Supply Pin). It contains interfaces for UART, SPI, and I2C.

7.2. LM35

The LM35 is a decent analogue temperature sensor chip right out of the box, with linearity of 0.25C and precision of 0.5C. The LM35 line from temperature sensors is accurate integrated circuit devices with result wave-forms that are directly proportional to temperature in degrees Celsius. The LM35 is easy to connect to reading or control circuitry because of its low output impedance, linear output, and excellent inherent calibration. Machine learning approaches in healthcare use the enormous amount of health data provided by the Internet of Things to improve patient outcomes.

7.3. MAX30100

Max30100 provides a full system solution by gathering both pulse rate and Oxygen saturation values simultaneously It minimizes the system's size and time. It can operate by consuming less power, which is a vital and efficient aspect for wearable devices. It is capable of generating quick results.

7.4. LCD Display

The output will be shown on a Liquid Crystal Display (LCD) in this system. LCD is a low-cost, energy-efficient panel as it uses less energy. As a result, energy is conserved and just a little amount of heat is emitted during operation. Even in stronger lighting, it fits perfectly. It is equipped with anti-glare technology. It is exceptionally small and thin. Magnetic fields have no effect on it. It is ideally suited for this system since it has great resolution and little geometric distortion. The LCD will display sensor values, which will subsequently be relayed to the cloud server.

8. Software Description

8.1. ARDUINO IDE

Arduino is a great code editor for projects that has user-friendly interfaces and a lot of built-in libraries. The Arduino IDE (Integrated Development Environment) is linked to the Arduino/NodeMCU. The person enters Arduino code here, which is subsequently transferred to the microcontroller, which executes it and communicates with the enabled devices. The Arduino IDE is essential for instructing the microcontroller (NodeMCU) to interface with the sensors via embedded C programming and retrieve data. It is user-friendly and simple to use. It is utilized by a bigger group of people.

8.2. THINGSPEAK

If the connection has been established to an IoT platform, “Thingspeak” is a great platform for integrating to a cloud server and making work much easier. ThingSpeak assists the user by offering real-time data, data processing, graphical analysis, and a web or mobile application. The thingspeak channel offers eight-fields of any data, three-location fields, and one-status field, which makes it possible for more information to be stored and analyzed in a simpler and more efficient manner. Thingspeak receives data from the nodeMCU, creates an immediate visualization of the info, and notifies the caregivers.

8.3. GOOGLE COLAB

Google Colab was created by Google in order to give unlimited access to GPUs and TPUs to everyone who requires them in order to build a ML and DL models. Google Colab is a more enhanced form of Jupyter Notebook. There are several tutorials available to help you understand and work with machine learning and neural networks. Using a few lines of code, it is simple to add data sets from various third parties. The data set is made up of sensor readings. It will have 1 or true if the sensor value is greater than critical value and 0 if it is lesser. Even from the notebook, terminal commands could well be run. It also offers free cloud services. Notebooks (code) may be easily saved and imported from Google Drive. Google Colab is used to integrate the data sets, which are then associated with the python code, which begins evaluating and comparing the provided data sets and produces needed data in less time.

9. Result and Discussion

The NodeMCU is connected to all sensors. ThingSpeak will obtain the data from the NodeMCU and save it further process. The hardware connection of the system is displayed below. The data of a person is analyzed and the result is been displayed. They display various results based on the patient present health and the measures to be taken to overcome the problem. It is displayed in graphical representation and also the coding produces the result in wording too as shown in Fig.2(a) to 2(c).

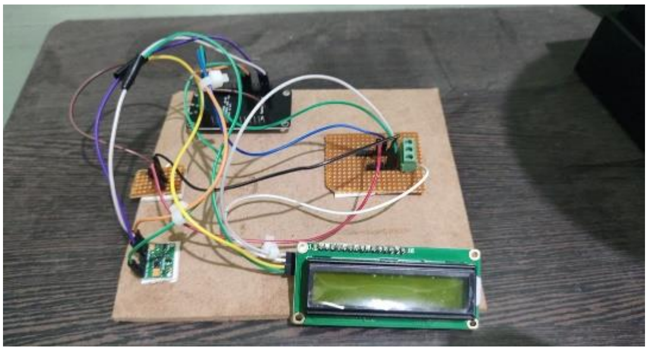

Fig.2(a). Hardware implementation front view

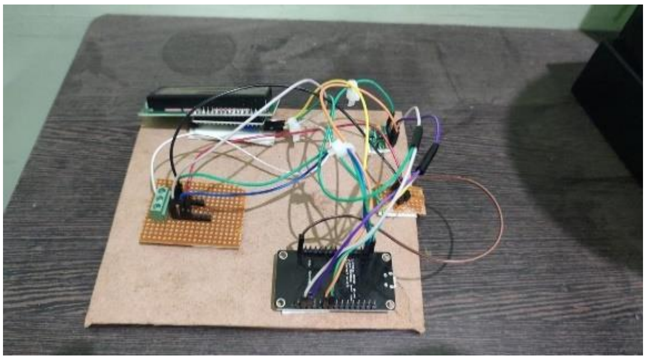

Fig.2(b). Hardware implementation back view

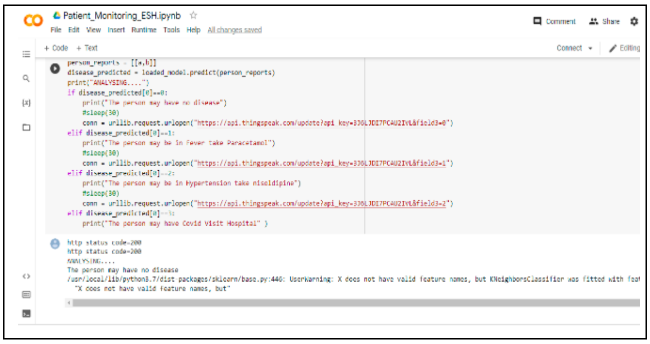

Fig.2(c). Coding that provides result as given

Finally, the stored data is retrieved and compared to the data set provided for machine learning using the KNN algorithm, with the closest result displayed in several graphical methods in the web application. The online application is accessed by the patient via mobile, laptop, or other devices.

10. Conclusion

Thus, all the parameters of the patient are sent and Machine learning is processed and the status and prescription is viewed in the Mobile Application. Patients benefit from ML-based Patient Monitoring systems because let them

allow to happily living their lives while receiving ongoing medical attention. Only serious issues or cases need to be handled by the clinic or doctor. Despite the fact that many patients monitoring systems are acquainted with the IP/OP medical treatment, patients are less competent and confident in utilizing this system. As a result, encouraging patients' active and voluntary engagement is critical. Communication among chronic illness sufferers is just as vital as engagement between medical practitioners and patients.

Declarations

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Consent for publication

Authors declare that they consented for the publication of this research work.

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